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Scientific American Supplement # 115
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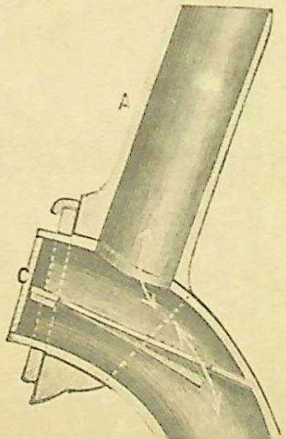
to the lungs, and it was probably to be explained as a reflex spasm set up by irritation of the nerves in the upper end of the wound.

While this dilatation was in progress, various attempts were made to procure a tube which would fit the peculiar shape of the wound. In this task I was indebted to Dr. Irvine and Mr. Foulds (dentist) for invaluable assistance. Dr. Irvine having suggested and embodied in a rough model the idea of reversing the relative position of the tubes, Mr. Foulds produced a tube (Fig. 2) which is at once light, smooth, easy to wear, and close-fitting to the wound. From the accompanying sketch it will be seen that this voice-tube is based on the plan of that of Gussenbauer, with essential modifications. For example, the lower tube slips into the upper one, thus permitting the upper tube, which is the more difficult to insert, to be put first into its position in the wound. And, again, at Mr. Foulds' suggestion, the reed-plate is not inclosed in a silver case, but is simply pushed into a groove in the sides of the lower tube, like a drawer. When pushed home, the reed-plate slopes downward, and the current of air from the lungs impinges upon the free end of the vibrating reed, instead of being reflected along it from the root, as in Gussenbauer's tube. This is found to give a better note than that produced by Gussenbauer's arrangement. I need not detail all the difficulties met with in fitting this tube to the wound. One of these was the determination of the length of the upper tube. The epiglottis having been left attached to the root of the tongue, it was necessary to leave the tube of just such a length as would allow the epiglottis to close over it in swallowing, and would at the same time keep the mouth end of the wound patent. The tendency of the uppermost limit of the wound to close over was for a time very troublesome, and interfered with the clearness of the voice in a capricious manner; while if, on the other hand, too long a tube were used, there was excessive irritation and salivation, the most of the saliva finding its way into the trachea, where it excited hard, painful coughing. The sketch (Fig. 3, see next page) shows the posi-

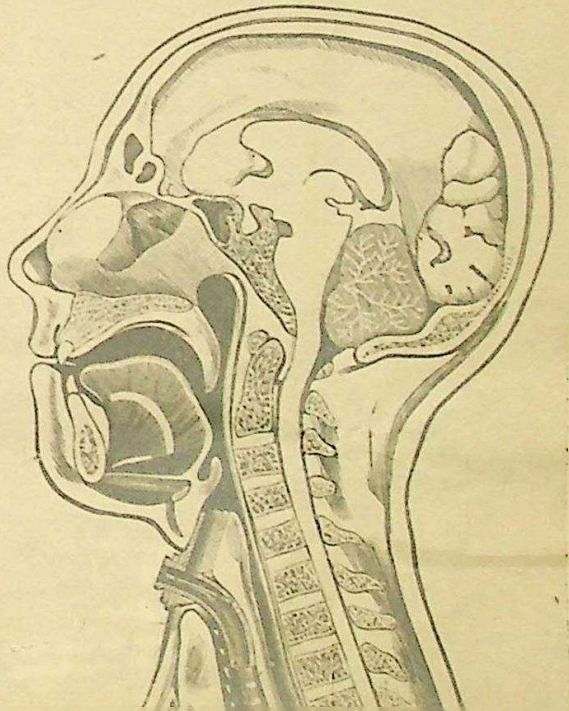
FIG. 2.



certain strength. All the reeds remain silent in ordinary breathing.

It is notable that the sound of the voice is interfered with by anything which even partially closes the upper end of the tube. If the tube, for example, be too short, and the soft parts fold themselves over the upper end, the voice is liable to be suddenly interrupted; while if the epiglottis lie far back over the end of the tube the pitch of the note is lowered and the tone itself damped and rendered less ringing. This seems akin to the effect of large tonsils, or other swelling above the glottis, in altering the air-current, and with it the voice—the glottis itself remaining quite healthy. The voice in such cases is more or less muffled and depressed in pitch. This muffling of the note follows whenever the exit of the sound is in any degree hindered. For when, the finger being placed on the aperture at C (Fig. 2), so as to close only that part of the opening which is below the reed plate, the sound is allowed to emerge through the half aperture above the reed-plate, we hear a higher and clearer note than we hear when, the whole of the aperture at C being closed, the sound is emitted at the upper end of the tube. This is still more marked when the same observation is made with the tube in the neck of the patient, indicating a further muffling by means of the mouth cavity. My friend Mr. Moodie was good enough to test this for me with the tuning-

FIG. 3.



EXTIRPATION OF THE LARYNX.

By DAVID FOULIS, M.D.

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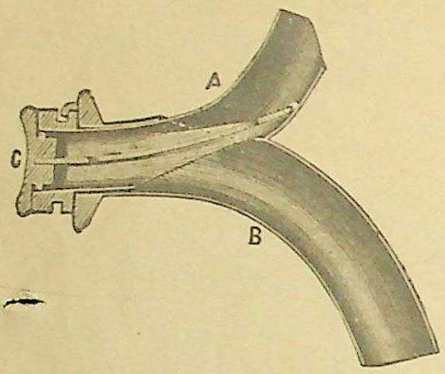
Four months have now elapsed since I removed the larynx, and the patient has returned to his home in a satisfactory state. I wish to detail the further steps which were necessary in order to bring about this result.

As soon as the wound appeared to be sufficiently contracted, I tried to introduce the voice-tube sent to me by H. Reiner, of Vienna. This apparatus (Fig. 1) consists of two tubes, one of which (B) passes into the open trachea, while the other (A), fitting into the tube B, passes upward to the epiglottis. Into the upper tube (A) slides a silver case containing a plate with a vibrating reed. The anterior opening of the apparatus is closed by the button (C), and the current of air is directed past the reed, and through the apertures in

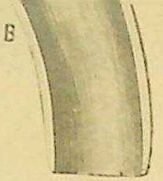
FIG. 1.



Sectional view of Gussenbauer's voice-tube (full size).
A, Upper tube, which passes up toward the mouth.
B, Lower tube, which enters the trachea.
C, Button with reed-plate attached.

the tubes. As the upward current impinges on the reed, the latter is thrown into vibrations, and a continuous musical note is produced, which is then modulated into vowels and consonants by the mouth.

At this stage several difficulties appeared. In the first place, the tube, owing to its shape and its small size, did not fit the wound, and the reed being besides rather stiff and difficult to sound, the apparatus was laid aside. I found also that the upper part of the wound had contracted very much, so that I could scarcely push the tip of my little finger into it. The enlargement of the upper part of the passage was therefore the first point to be attended to, and this I effected by inserting my finger into it for a short time daily, until in a week or so I was able to pass my middle finger from the wound in the neck up into the fauces, and to leave it in the channel for a minute or two. This upper end of the wound was very sensitive, possibly owing to the presence of the end twigs of the superior laryngeal nerve, and the introduction of the finger was followed by violent fits of spasmodic coughing, accompanied by a sort of suffocative spasm. This happened in spite of the fact that, the upper end of the trachea being wide open, the air had free access



Sectional view of voice-tube used by the patient (full size).
A, Upper tube. B, Lower tube slipping into the upper tube and holding the reed-plate and button (C).

tion of the tube in the throat, and the length now fixed on as the best for the upper end. For precaution's sake a cork is inserted into the upper end of the tube at meal-times, any accidental spasms of coughing being undesirable in the suspicious state of the apex of the right lung, alluded to in my former paper. But the amount of salivation having greatly diminished, the use of the cork is now less necessary.

The question of the formation of the reed was also of much interest. The reed in the Vienna instrument was made of thin German silver plate, and those which Mr. Foulds at first made were of brass. Dr. Irvine found, in the course of experiment, that soft vulcanite answered well for the purpose; and on the model of the one so made the patient himself has been able to manufacture reeds of various materials—ivory, horn, vulcanite, cane, etc.—with which he amuses himself. I had some reeds of German silver and steel made by a jeweler. Latterly, Mr. Foulds has made one of an alloy of silver and brass, which gives the richest tone of all, and which is the favorite one with the patient owing to the ease with which it is vibrated. The patient has thus a large number of voices at command; and it is very instructive to watch the variations in the timbre or quality of the voice in changing from one reed to the other. The softest and perhaps the most natural notes are given by the non-metallic reeds, those made of metal giving a more ringing tone. With the same buccal cavity, we have a tenor or baritone quality imparted to the voice by the use of one or other of the reeds, which fact goes to confirm the opinion already expressed by authorities that the timbre of the human voice depends as much upon the density, elasticity, and other qualities of the vocal cords as on the accentuation of particular sound waves in the buccal cavity.

The articulation of the patient with this apparatus is wonderful. Except for the monotony, it cannot be distinguished from the natural voice. The vowels are perfectly clear and distinct, both in whispering with the reed out and in intoning with the reed in the tube; proving, if proof were wanted, that the vowels are the product of changes in the shape of the buccal cavity, and are not formed by alterations of the glottis. I had the pleasure of showing the patient to Professors Sir William Thomson, M'Kendrick, Clelland, Graham Bell, and others at the University (on November 13th), to the Pathological and Clinical Society (November 13th), and to the Philosophical Society of Glasgow (November 21st), and on these occasions he was able to convince the gentlemen present of the reality of his vocal powers. More recently, having become more expert at the manufacture of reeds, my patient has made for himself a vulcanite reed with which he can positively roar. This reed requires, of course, a stronger current of air to make it vibrate than the others require, they in turn vibrating only in an air-current of a

Sectional view of head and neck, showing the relations of the voice-tube to the soft parts, and the manner in which it replaces the larynx. (Modified after Braune's plates.)

fork, and he determined a difference of a half or even a whole tone, metallic reeds giving the least variation. It was sufficiently marked to allow of dissent from the opinion expressed by M. Gavarret that the oral cavity is too short to influence the pitch of the note produced by the vocal cords. It appeared to indicate rather that the note is materially altered in pitch in its transmission through the mouth. This is a point which might be elucidated by observation of the sound in cases of cut-throat. At Dr. Irvine's suggestion a further test was applied. The patient was directed to sound a vowel over a considerable period of time, during which the sound was at first allowed to come out at the front aperture of the tube, then through the mouth, and finally transmitted through a tubular roll of paper held closely to the mouth. As these steps were taken the sound became gradually lowered in pitch, the reed of course remaining the same. There could here be no involuntary modification of the glottis to suit the tube, and the experiment showed vividly the function which the buccal cavity exercises with respect to the pitch of the voice.

In concluding this notice I must allude to the general health of the patient and to the prospect of the recurrence of the growth. There is as yet no sign of the latter, and the two glands, which before the operation was performed were large and dangerous-looking, are now very small. They can still be felt on careful examination, and should they give any trouble they can be excised. The patient remains as before, rather subject to colds, and during his stay in the Nursing Home there was a sharp attack of bronchitis in the right lung, with crepitant râles at the apex and half way down the lung, with an evening temperature of 99° to 101°. With this there were slight sweatings at night; but after causing us much anxiety for a fortnight, this passed away. The temperature is now nearly normal, betraying an occasional tendency to an evening rise of half a degree or so. There is just a trace of sweating at night at rare intervals. To physical examination the right lung is as sound as it has been since I first saw the patient, an opinion confirmed by Dr. Finlayson, who has kindly examined the chest from time to time.—*Lancet.*

artificial
larynx